COMPRESSIBILITY BEHAVIOUR OF MAGNESIUM PHOSPHOGYPSUM AMENDED LATERITE

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I/We* hereby declare that I/We* have checked this thesis/project* and in my/our* opinion, this thesis/project* is adequate in terms of scope and quality for the award of the Bachelor Degree of Civil Engineering

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Perlombongan laterit bukan aktiviti ekonomi baru untuk Malaysia. Perlombongan laterit telah berlaku di negeri Johor sejak awal tahun 2000. Laterit dianggap sebagai tanah bermasalah kerana ia merupakan produk sisa. Terdapat beberapa sebab mengapa perlombongan laterit boleh menyebabkan masalah jika isu itu tidak diselesaikan atau dikawal. Kajian ini memberi tumpuan kepada tingkah laku mampatan Magnesium Phospogypsum berkenaan dengan ujian oedometer. Hasilnya berguna untuk dilaksanakan di industri untuk menyediakan pelupusan sisa yang efisien atau menggunakan bahan buangan dalam konteks masalah sisa industri. Hasil dari ujian oedometer mendedahkan bahawa magnitud dan kadar pengurangan isipadu spesimen tanah berkurang jika mengalami tekanan menegak yang berbeza. Ini disebabkan oleh ubah bentuk zarah tanah, penempatan semula zarah-zarah tanah dan pengusiran air atau udara dari ruang kosong. Tiga sampel yang berbeza digunakan dalam kajian ini. Kandungan air sebelum ujian untuk sampel 1, sampel 2 dan sampel 3 masing-masing adalah 38.3%, 49.1% dan 47.5%. Selepas eksperimen, kandungan air untuk setiap beban menurun apabila tekanan meningkat. Untuk sampel 1, kandungan air menurun dari 34.54 hingga 22.74, sampel 2 menurun dari 44.4% kepada 31.00% dan sampel 3 menurun daripada 38.1 kepada 25.3 masing-masing. Nisbah kekosongan awal sebelum ujian untuk sampel 1, sampel 2 dan sampel 3 masing-masing adalah 1.0131%, 1.3039% dan 1.2472%. Selepas percubaan, nisbah kebarangkalian untuk setiap beban menurun apabila tekanan meningkat. Nisbah kekosongan selepas kebolehmampatan untuk sampel 1 menurun dari 0.9725 kepada 0.3364, sampel 2 dari 1.2623 hingga 0.8088 dan sampel 3 dari 1.2342 kepada 0.7586 masing-masing Temuan ini menunjukkan bahawa tingkah laku mampatan Magnesium Phosphogypsum berkaitan dengan tekanan yang dikenakan ke sampel tanah.

ABSTRACT

Laterite mining is not a new economic activity for Malaysia. The mining of laterite has taken place in the state of Johor since early 2000. Laterite is considered as problematic soil because it is a waste product. There are a number of reasons why laterite mining can cause problem which will subsequently propagate to problems if the issue is not resolved or controlled. This research focused on the compressibility behaviour of Magnesium Phospogypsum with respect to oedometer test. The result is useful to be implemented in industry to provide efficient waste disposal or reuse the waste materials in the context of industrial waste issues. Result from the oedometer test reveal that the magnitude and rate of volume decrease that a laterally confined soil specimen undergoes when subjected to different vertical pressures. This is caused by deformation of soil particles, relocations of soil particles and expulsion of water or air from the void spaces. Three different sample is used in this research. The water content before test for sample 1, sample 2 and sample 3 are 38.3%, 49.1% and 47.5% respectively. After the experiment, water content for each loading decreases as the pressure increases. For sample 1, water content decrease from 34.54 to 22.74, sample 2 decrease from 44.4% to 31,00% and sample 3 decrease from 38.1 to 25.3 respectively. The initial void ratio before test for sample 1, sample 2 and sample 3 are 1.0131%, 1.3039% and 1.2472% respectively. After the experiment, void ratio for each loading decreases as the pressure increases. The void ratio after compressibility for sample 1 decrease from 0.9725 to 0.3364, sample 2 from 1.2623 to 0.8088 and sample 3 from 1.2342 to 0.7586 respectively This finding implies that the compressibility behaviour of Magnesium Phosphogypsum relate to the pressure impose to the soil sample.

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LIST OF SYMBOLS

Al	Aluminium
Al_2O_3	Alumina
AlOH	Aluminium Hydoxide
Al(OH)3	Gibbsite
AlO(OH)	Boehmite
C	Carbon
Ca	Calcium
Cr	Chromium
Cu	Copper
Fe	Iron
Ga	Galium
K	Potassium
Mg	Magnesium
Mn	Manganese
Na	Sodium
P	Phosphorus
S	Sulphur
Si	Silicon
Ti	Titanium
V	Vanadium
Zn	Zinc

LIST OF ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ASTM	American Standard Testing Method
BRDA	Bauxite Residue Disposal Areas
BS	British Standard
BSCS	British Soil Classification System
LL	Liquid Limit
PI	Plasticity Index
PL	Plastic Limit
PM	Particular Matter

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Nowadays, this becomes a common issue which happen every day in all over the world. Mineral resources are very crucial for country's mining sector development and Malaysia's national economy during the 20th century. In Malaysia, mineral resources such as iron, tin, gold, coal, silica sand, laterite, antimony, barite, clays, copper, lead and limestone have played important roles in country's mineral production, although exploitation of some minerals had decreased significantly (Kusin, Azani, Hasan, & Sulong, 2018). Environmental pollution which faced in Malaysia has a long history and is becoming serious issue since this few years due to the economic development and increased in industrialization activities. It leads to the degradation of quality of life by consuming food and water contaminated with chemical, biological and radioactive materials, either directly or indirectly. Pollution is the introduction of a noxious waste emitted into the environment and caused instability and harm to the ecosystem which will be dangerous to humans and creature.

Laterite mining is not known to most Malaysian. Potential impacts are expected to go beyond physical environment and physical illness if the situation is not controlled. Loss of economic potentials, and the presence of unpleasant red dust causing mental distress, anger and community outrage (Abdullah, Mohamed, Sulaiman, Zakaria, & Abdul Rahim, 2016). Mining offers some exciting economic opportunities for various parties including individual land owners. Nevertheless, the extensive and uncontrolled mining activities have great potentials to cause adverse impacts on the environment, health and quality of life of the people living in the affected areas (Abdullah, Mohamed, Sulaiman, Zakaria, & Abdul Rahim, 2016). Laterite mining is not a new economic activity for Malaysia. The mining of laterite has taken place in the state of Johor since

early 2000 (Anak Ginung & Abdullah, 2015). Whilst mining operation in Teluk Ramunia Johor has been operating for more than 15 years without much controversy, it has created a different scenario within a short period of time. Extensive and aggressive mining which include transporting and stockpiling of laterite in huge quantities cause environmental problems to emerge within a short period of time leading to community outrage (Abdullah et al., 2016).

New adaption for the waste management planning should be considered to provide efficient use of laterite or reuse the materials in the context of industrial laterite issue. Related to this issue, health of people and health of planet that we live should be protected. Aggressive uncontrolled mining, if sustained over time will cause irreversible changes to the state of the environment that threatens the ecosystems. The polluted ecosystems have great potential to create chronic and unpredictable exposures, leading to direct or indirect, immediate and long-term potential impacts on health. A number of physical, chemical, biological, ergonomic, and psychosocial hazards exist throughout the mining process, as described in the article by Donoghue and Olney (Donoghue, Frisch, & Olney, 2014). There are a number of reasons why laterite mining can cause problem which will subsequently propagate to problems if the issue is not resolved or controlled. One of the reasons is related to its location which is close to the human settlement area. Other reason is associated with unsustainable mining processes that lead to very extensive and aggressive mining activities.

Oedometer test is a fundamental property in soil physics and soil mechanics (Heshmati & Motahari, 2012). Oedometer is a geotechnical investigation performed in geotechnical engineering that measures a soil's consolidation properties. Equipment and procedures have been developed at NGI for handling very soft clays or other difficult materials to obtain as reliable and credible parameters as possible (Equipment, 1986). Oedometer tests are performed by applying different loads to a soil sample and measuring the deformation response. It defines the relationship between moisture content and compressibility of soil. Besides, oedometer test contains a lot of importance information such as pressure (kPa) and void ratio (e) on the computer simultaneously.

1.2 Problem Statement

Laterite is the principal ore of alumina (Al_2O_3), which is used to produce aluminum (Al). It is composed of hydrated aluminum oxides, hydrated aluminosilicates, iron oxides, hydrated iron oxides, titanium oxide, and silica. Laterite is a residual rock formed from the weathering of various igneous, sedimentary, and metamorphic rocks. These parent rocks have been exposed to long periods (millions of years) of weathering under tropical, subtropical, or very wet temperate conditions. Open mining involves substantial clearing and removal of land. The processes of excavating, removal of top soil and vegetation, transportation of laterite and unwanted elements and stockpiling of laterite cause degradation of air quality mainly related to dust pollution. Dust is a solid particulate matter, in the size range of 1 to 75 microns in diameter. Dust smaller than 10 micrometer in diameter, known as particulate matter PM10 and PM2.5 are of great health concern because it can be inhaled deep into the respiratory system. Data collected by researcher in December 2015, revealed that 24-hour PM10 level ($\mu g/m^3$) ranged from 164 to 277$\mu g/m^3$ which exceeded the Malaysian National Ambient Air Quality Standard 2015. The impact may persist if there is no proper rehabilitation plan done to the exploited area. It is important to emphasize on sustainable mining practices such as rehabilitation in order to avoid other serious laterite issues in the future. Furthermore, application of magnesium phosphpgypsum in an effective ways, laterite problem can be reduced as well as make benefits on laterite.

1.3 Research Objectives

The aim of this research is to investigate the compressibility behaviour of magnesium phosphogypsum amended laterite:

i. To determine the geotechnical properties of magnesium phosphogypsum amended laterite.

ii. To establish the pressure-water content and pressure-void ratio relationships.

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